Isochoric Heat Capacity Measurements for Heavy Water Near the Critical Point

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The results of isochoric heat capacity measurements of D_2O as a function of temperature at a number of fixed densities will be presented. The measurements cover a range in temperature from 620 to 670 K. The measurements were performed at 7 densities between 290 and 420 kg·m^3. We used a high-temperature, high-pressure, adiabatic, and nearly constant-volume calorimeter. The inner volume of the calorimeter is 440.43 ± 0.05 cm^3 at temperature of 296.65 K and pressure of 0.1 MPa. Changes in the volume of the calorimeter due to changes in temperature ΔV_T and pressure ΔV_P were determined both experimentally and by calculations. The heat capacity of the empty calorimeter C_0 was measured using reference fluids (n-heptane and helium) with well-known (uncertainties 0.5 % and 0.1%, respectively) isobaric heat capacities at 0.1 MPa. The average value of C_0 is about 232 J·K^{-1} in a temperature range between 390 and 670 K. The temperature of the sample was measured with a *PRT (PTS-10)*. The uncertainty in the temperature measurements was less than 10mK. Uncertainties of the heat capacity measurements are estimated to be 2-3%. Measurements were made in the two-phase and one-phase regions. The calorimeter construction also enables measurements of *PVT* and the temperature derivative $(\partial P/\partial T)_V$ along each measured isochore. The experimental temperature behavior of C_V in the one- and two-phase regions, including the coexistence curve near the critical point will be discussed. The experimental values of temperatures at saturation $T_S(\rho)$ on each measured isochore also were determined using a quasi-static thermogram method. The uncertainty of the phase transition temperature measurements is about ±0.02 K. From our analysis of the T_S-ρ_S and temperature derivative $(\partial P/\partial T)_V$ data, the values of critical parameters (T_C, ρ_C, P_C) for D_2O were estimated.

The derived C_V data for D_2O are compared with values predicted from a recent parametric crossover equation of state by Kiselev, Abdulagatov, and Harvey [*Int. J. Thermophys* .**20**, 563 (1999)] and previous measurements of Mursalov (Ph. D. Thesis, 1975).